

WHAT IS CLAIMED IS:

1 1. A method of determining a network performance metric in a network,
2 wherein said network comprises a plurality of network elements and each one of said
3 network elements is coupled to at least one other of said network elements by at least
4 one of a plurality of links, comprising:

5 forming a first set of network element pairs, said first set of network element
6 pairs comprising a plurality of pairs of said network elements;
7 ordering a first plurality of network element pairs comprising ones of network
8 element pairs in said first set of network element pairs;
9 forming a second set of network element pairs, wherein said second set of
10 network element pairs comprises ones of said network element pairs in
11 said first set of network element pairs;
12 measuring a measured network performance metric between a first network
13 element pair, wherein said first network element pair comprises a first
14 network element and a second network element of one of said network
15 element pairs in said second set of network element pairs; and
16 computing a computed network performance metric between a second network
17 element pair using said measured network performance metric, wherein
18 said second network element pair comprises a first network element
19 and a second network element of said network element pair in said first
20 set of network element pairs.

1 2. The method of claim 1, wherein said computed network performance
2 metric is computed using a relationship between said first and said second network
3 element pairs.

1 3. The method of claim 1, wherein said ordering comprises:
2 identifying a plurality of network elements, wherein each one of said plurality
3 of network elements is one of a network element pair in said first set of
4 network element pairs;

5 assigning one of a plurality of preferences to each one of said plurality of
6 network elements; and
7 sorting said network element pairs in said first set of network element pairs
8 based on said plurality of preferences.

1 4. The method of claim 3, wherein said sorting comprises:
2 for each one of said network element pairs in said first set of network element
3 pairs, swapping a first network element and a second network element
4 in said each one of said network element pairs in said first set of
5 network element pairs, if a preference of said first network element in
6 said each one of said network element pairs in said first set of network
7 element pairs is less than a preference of said second network element
8 in said each one of said network element pairs in said first set of
9 network element pairs;
10 sorting said network element pairs in said first set of network element pairs
11 based on a preference of a present first network element of said each
12 one of said network element pairs in said first set of network element
13 pairs; and
14 sorting said network element pairs in said first set of network element pairs
15 based on a preference of a present second network element of said each
16 one of said network element pairs in said first set of network element
17 pairs.

1 5. The method of claim 1, further comprising:
2 forming a first matrix, wherein each row in said first matrix corresponds to a
3 network element pair of said first set of network element pairs; and
4 determining a set of independent rows of said first matrix.

1 6. The method of claim 5, wherein said set of independent rows of said
2 first matrix is a maximal set of independent rows of said first matrix.

1 7. The method of claim 5, wherein said forming said second set of
2 network element pairs comprises:
3 including independent network element pairs in said second set of network
4 element pairs, wherein
5 said independent network element pairs are ones of said network
6 element pairs in said first set of network element pairs
7 corresponding to rows of said first matrix in said set of
8 independent rows of said first matrix.

1 8. The method of claim 1, further comprising:
2 forming a delay components vector;
3 forming a first matrix, wherein
4 said first matrix describes a relationship between said delay
5 components vector and a delay between each of said network
6 element pairs of said first set of network element pairs,
7 each row in said first matrix corresponds to a network element pair of
8 said first set of network element pairs; and
9 determining a set of independent rows of said first matrix, wherein said
10 forming said second set of network element pairs comprises
11 including independent network element pairs in said second set of
12 network element pairs, and
13 said independent network element pairs are ones of said network
14 element pairs in said first set of network element pairs
15 corresponding to rows of said first matrix in said set of
16 independent rows of said first matrix.

1 9. The method of claim 8, wherein said delay components vector
2 comprises:

3 a representation of a delay within each network element of each network
4 element pair of said first set of network element pairs for said each
5 network element pair of said first set of network element pairs, and
6 a representation of a delay between network elements of said each network
7 element pair of said first set of network element pairs for said each
8 network element pair of said first set of network element pairs.

1 10. The method of claim 8, further comprising:

2 forming a second matrix, wherein
3 said second matrix describes a relationship between a plurality of
4 independent delays and a non-independent delay,
5 said plurality of independent delays comprise a delay between network
6 elements in each network element pair of said second set of
7 network element pairs, and
8 said non-independent delay comprises a delay between network
9 elements in a network element pair of said first set of network
10 element pairs that is not in said second set of network element
11 pairs.

1 11. The method of claim 10, wherein said forming said second matrix
2 comprises performing a Gaussian elimination using said first and said second
3 matrices.

1 12. The method of claim 10, wherein said computing said computed
2 network performance metric comprises:
3 multiplying said measured performance metric by an element of said second
4 matrix.

1 13. A computer system comprising:
2 a processor;
3 a network interface, coupled to said processor and to a network, wherein said
4 network comprises a plurality of network elements and each one of
5 said network elements is coupled to at least one other of said network
6 elements by at least one of a plurality of links;
7 computer readable medium coupled to said processor; and
8 computer code, encoded in said computer readable medium, configured to
9 cause said processor to:
10 form a first set of network element pairs, said first set of network
11 element pairs comprising a plurality of pairs of said network
12 elements;
13 order a first plurality of network element pairs comprising ones of
14 network element pairs in said first set of network element pairs;
15 form a second set of network element pairs, wherein said second set of
16 network element pairs comprises ones of said network element
17 pairs in said first set of network element pairs;
18 measure a measured network performance metric between a first
19 network element pair, wherein said first network element pair
20 comprises a first network element and a second network
21 element of one of said network element pairs in said second set
22 of network element pairs; and
23 compute a computed network performance metric between a second
24 network element pair using said measured network
25 performance metric, wherein said second network element pair
26 comprises a first network element and a second network
27 element of said network element pair in said first set of network
28 element pairs.

1 14. The computer system of claim 13, wherein said computed network
2 performance metric is computed using a relationship between said first and said
3 second network element pairs.

1 15. The computer system of claim 13, wherein said computer code
2 configured to cause said processor to order said first plurality of network element
3 pairs, is further configured to cause said processor to:
4 identify a plurality of network elements, wherein each one of said plurality of
5 network elements is one of a network element pair in said first set of
6 network element pairs;
7 assign one of a plurality of preferences to each one of said plurality of network
8 elements; and
9 sort said network element pairs in said first set of network element pairs based
10 on said plurality of preferences.

1 16. The computer system of claim 15, wherein said computer code
2 configured to cause said processor to sort said network element pairs in said first set
3 of network element pairs based on said plurality of preferences, is further configured
4 to cause said processor to:
5 for each one of said network element pairs in said first set of network element
6 pairs, swap a first network element and a second network element in
7 said each one of said network element pairs in said first set of network
8 element pairs, if a preference of said first network element in said each
9 one of said network element pairs in said first set of network element
10 pairs is less than a preference of said second network element in said
11 each one of said network element pairs in said first set of network
12 element pairs;
13 sort said network element pairs in said first set of network element pairs based
14 on a preference of a present first network element of said each one of

15 said network element pairs in said first set of network element pairs;
16 and
17 sort said network element pairs in said first set of network element pairs based
18 on a preference of a present second network element of said each one
19 of said network element pairs in said first set of network element pairs.

1 17. The computer system of claim 13, wherein said computer code is
2 further configured to cause said processor to:
3 form a first matrix, wherein each row in said first matrix corresponds to a
4 network element pair of said first set of network element pairs; and
5 determine a set of independent rows of said first matrix.

1 18. The computer system of claim 17, wherein said set of independent
2 rows of said first matrix is a maximal set of independent rows of said first matrix.

1 19. The computer system of claim 17, wherein said computer code
2 configured to cause said processor to form said second set of network element pairs, is
3 further configured to cause said processor to:
4 include independent network element pairs in said second set of network
5 element pairs, wherein
6 said independent network element pairs are ones of said network
7 element pairs in said first set of network element pairs
8 corresponding to rows of said first matrix in said set of
9 independent rows of said first matrix.

1 20. The computer system of claim 13, wherein said computer code is
2 further configured to cause said processor to:
3 form a delay components vector;
4 form a first matrix, wherein
5 said first matrix describes a relationship between said delay
6 components vector and a delay between each of said network
7 element pairs of said first set of network element pairs,

8 each row in said first matrix corresponds to a network element pair of
9 said first set of network element pairs; and
10 determine a set of independent rows of said first matrix, wherein said forming
11 said second set of network element pairs comprises
12 including independent network element pairs in said second set of
13 network element pairs, and
14 said independent network element pairs are ones of said network
15 element pairs in said first set of network element pairs
16 corresponding to rows of said first matrix in said set of
17 independent rows of said first matrix.

1 21. The computer system of claim 20, wherein said delay components
2 vector comprises:
3 a representation of a delay within each network element of each network
4 element pair of said first set of network element pairs for said each
5 network element pair of said first set of network element pairs, and
6 a representation of a delay between network elements of said each network
7 element pair of said first set of network element pairs for said each
8 network element pair of said first set of network element pairs.

1 22. The computer system of claim 20, wherein said computer code is
2 further configured to cause said processor to:
3 form a second matrix, wherein
4 said second matrix describes a relationship between a plurality of
5 independent delays and a non-independent delay,
6 said plurality of independent delays comprise a delay between network
7 elements in each network element pair of said second set of
8 network element pairs, and
9 said non-independent delay comprises a delay between network
10 elements in a network element pair of said first set of network

11 element pairs that is not in said second set of network element
12 pairs.

1 23. The computer system of claim 22, wherein said computer code
2 configured to cause said processor to form said second matrix, is further configured to
3 cause said processor to:
4 perform a Gaussian elimination using said first and said second matrices.

1 24. The computer system of claim 22, wherein said computer code
2 configured to cause said processor to compute a computed network performance
3 metric, is further configured to cause said processor to:

4 multiply said measured performance metric by an element of said second
5 matrix.

1 25. A computer program product encoded in computer readable media,
2 said computer program product comprising:
3 a first set of instructions, executable on a computer system, configured to form
4 a first set of network element pairs, said first set of network element
5 pairs comprising a plurality of pairs of said network elements;
6 a second set of instructions, executable on said computer system, configured to
7 order a first plurality of network element pairs comprising ones of
8 network element pairs in said first set of network element pairs;
9 a third set of instructions, executable on said computer system, configured to
10 form a second set of network element pairs, wherein said second set of
11 network element pairs comprises ones of said network element pairs in
12 said first set of network element pairs;
13 a fourth set of instructions, executable on said computer system, configured to
14 measure a measured network performance metric between a first
15 network element pair, wherein said first network element pair
16 comprises a first network element and a second network element of

17 one of said network element pairs in said second set of network
18 element pairs; and
19 a fifth set of instructions, executable on said computer system, configured to
20 compute a computed network performance metric between a second
21 network element pair using said measured network performance
22 metric, wherein said second network element pair comprises a first
23 network element and a second network element of said network
24 element pair in said first set of network element pairs.

1 26. The computer program product of claim 25, wherein fifth set of
2 instructions cause said computer system to compute said computed network
3 performance metric using a relationship between said first and said second network
4 element pairs.

1 27. The computer program product of claim 25, wherein said second set of
2 instructions comprises:
3 a sixth set of instructions, executable on said computer system, configured to
4 identify a plurality of network elements, wherein each one of said
5 plurality of network elements is one of a network element pair in said
6 first set of network element pairs;
7 a seventh set of instructions, executable on said computer system, configured
8 to identify a plurality of network elements, wherein each one of said
9 plurality of network elements is one of a network element pair in said
10 first set of network element pairs; and
11 a eighth set of instructions, executable on said computer system, configured to
12 identify a plurality of network elements, wherein each one of said
13 plurality of network elements is one of a network element pair in said
14 first set of network element pairs.

1 28. The computer program product of claim 27, wherein said eighth set of
2 instructions comprises:

3 a first sub-set of instructions, executable on said computer system, configured
4 to, for each one of said network element pairs in said first set of
5 network element pairs, swap a first network element and a second
6 network element in said each one of said network element pairs in said
7 first set of network element pairs, if a preference of said first network
8 element in said each one of said network element pairs in said first set
9 of network element pairs is less than a preference of said second
10 network element in said each one of said network element pairs in said
11 first set of network element pairs;

12 a second sub-set of instructions, executable on said computer system,
13 configured to sort said network element pairs in said first set of
14 network element pairs based on a preference of a present first network
15 element of said each one of said network element pairs in said first set
16 of network element pairs; and

17 an third sub-set of instructions, executable on said computer system,
18 configured to sort said network element pairs in said first set of
19 network element pairs based on a preference of a present second
20 network element of said each one of said network element pairs in said
21 first set of network element pairs.

1 29. The computer program product of claim 25, further comprising:
2 a sixth set of instructions, executable on said computer system, configured to
3 form a first matrix, wherein each row in said first matrix corresponds
4 to a network element pair of said first set of network element pairs; and
5 a seventh set of instructions, executable on said computer system, configured
6 to determine a set of independent rows of said first matrix.

1 30. The computer program product of claim 29, wherein said set of
2 independent rows of said first matrix is a maximal set of independent rows of said
3 first matrix.

1 31. The computer program product of claim 29, wherein said third set of
2 instructions comprises:

3 a first sub-set of instructions, executable on said computer system, configured
4 to include independent network element pairs in said second set of
5 network element pairs, wherein
6 said independent network element pairs are ones of said network
7 element pairs in said first set of network element pairs
8 corresponding to rows of said first matrix in said set of
9 independent rows of said first matrix.

1 32. The computer program product of claim 25, further comprising:
2 a sixth set of instructions, executable on said computer system, configured to
3 form a delay components vector;
4 a seventh set of instructions, executable on said computer system, configured
5 to form a first matrix, wherein
6 said first matrix describes a relationship between said delay
7 components vector and a delay between each of said network
8 element pairs of said first set of network element pairs,
9 each row in said first matrix corresponds to a network element pair of
10 said first set of network element pairs; and
11 a eighth set of instructions, executable on said computer system, configured to
12 determine a set of independent rows of said first matrix, wherein said
13 forming said second set of network element pairs comprises
14 including independent network element pairs in said second set of
15 network element pairs, and

16 said independent network element pairs are ones of said network
17 element pairs in said first set of network element pairs
18 corresponding to rows of said first matrix in said set of
19 independent rows of said first matrix.

1 33. The computer program product of claim 32, wherein said delay
2 components vector comprises:
3 a representation of a delay within each network element of each network
4 element pair of said first set of network element pairs for said each
5 network element pair of said first set of network element pairs, and
6 a representation of a delay between network elements of said each network
7 element pair of said first set of network element pairs for said each
8 network element pair of said first set of network element pairs.

1 34. The computer program product of claim 32, further comprising:
2 a ninth set of instructions, executable on said computer system, configured to
3 form a second matrix, wherein
4 said second matrix describes a relationship between a plurality of
5 independent delays and a non-independent delay,
6 said plurality of independent delays comprise a delay between network
7 elements in each network element pair of said second set of
8 network element pairs, and
9 said non-independent delay comprises a delay between network
10 elements in a network element pair of said first set of network
11 element pairs that is not in said second set of network element
12 pairs.

1 35. The computer program product of claim 34, wherein said ninth set of
2 instructions comprises:

3 a first sub-set of instructions, executable on said computer system, configured
4 to perform a Gaussian elimination using said first and said second
5 matrices.

1 36. The computer program product of claim 34, wherein said fifth set of
2 instructions comprises:

3 a first sub-set of instructions, executable on said computer system, configured
4 to multiply said measured performance metric by an element of said
5 second matrix.

1 37. A computer system comprising:

2 a network interface, coupled to said processor and to a network, wherein said
3 network comprises a plurality of network elements and each one of
4 said network elements is coupled to at least one other of said network
5 elements by at least one of a plurality of links;
6 means for forming a first set of network element pairs, said first set of network
7 element pairs comprising a plurality of pairs of said network elements;
8 means for ordering a first plurality of network element pairs comprising ones
9 of network element pairs in said first set of network element pairs;
10 means for forming a second set of network element pairs, wherein said second
11 set of network element pairs comprises ones of said network element
12 pairs in said first set of network element pairs
13 means for measuring a measured network performance metric between a first
14 network element pair, wherein said first network element pair
15 comprises a first network element and a second network element of
16 one of said network element pairs in said second set of network
17 element pairs; and

18 means for computing a computed network performance metric between a
19 second network element pair using said measured network
20 performance metric, wherein said second network element pair
21 comprises a first network element and a second network element of
22 said network element pair in said first set of network element pairs.

1 38. The method of claim 37, wherein said computed network performance
2 metric is computed using a relationship between said first and said second network
3 element pairs.

1 39. The computer system of claim 37, further comprising:
2 means for identifying a plurality of network elements, wherein each one of
3 said plurality of network elements is one of a network element pair in
4 said first set of network element pairs;
5 means for assigning one of a plurality of preferences to each one of said
6 plurality of network elements; and
7 means for sorting said network element pairs in said first set of network
8 element pairs based on said plurality of preferences.

1 40. The computer system of claim 39, wherein said sorting means
2 comprises:
3 means, for each one of said network element pairs in said first set of network
4 element pairs, for swapping a first network element and a second
5 network element in said each one of said network element pairs in said
6 first set of network element pairs, if a preference of said first network
7 element in said each one of said network element pairs in said first set
8 of network element pairs is less than a preference of said second
9 network element in said each one of said network element pairs in said
10 first set of network element pairs.
11 means for sorting said network element pairs in said first set of network
12 element pairs based on a preference of a present first network element

13 of said each one of said network element pairs in said first set of
14 network element pairs; and
15 means for sorting said network element pairs in said first set of network
16 element pairs based on a preference of a present second network
17 element of said each one of said network element pairs in said first set
18 of network element pairs.

1 41. The computer system of claim 37, further comprising:
2 means for forming a first matrix, wherein each row in said first matrix
3 corresponds to a network element pair of said first set of network
4 element pairs; and
5 means for determining a set of independent rows of said first matrix.

1 42. The computer system of claim 41, wherein said set of independent
2 rows of said first matrix is a maximal set of independent rows of said first matrix.

1 43. The computer system of claim 41, wherein said means for forming said
2 second set of network element pairs comprises:
3 means for including independent network element pairs in said second set of
4 network element pairs, wherein
5 said independent network element pairs are ones of said network
6 element pairs in said first set of network element pairs
7 corresponding to rows of said first matrix in said set of
8 independent rows of said first matrix.

1 44. The computer system of claim 37, further comprising:
2 means for forming a delay components vector;
3 means for forming a first matrix, wherein
4 said first matrix describes a relationship between said delay
5 components vector and a delay between each of said network
6 element pairs of said first set of network element pairs,

7 each row in said first matrix corresponds to a network element pair of
8 said first set of network element pairs; and
9 means for determining a set of independent rows of said first matrix, wherein
10 said forming said second set of network element pairs comprises
11 including independent network element pairs in said second set of
12 network element pairs, and
13 said independent network element pairs are ones of said network
14 element pairs in said first set of network element pairs
15 corresponding to rows of said first matrix in said set of
16 independent rows of said first matrix.

1 45. The computer system of claim 44, wherein said delay components
2 vector comprises:
3 a representation of a delay within each network element of each network
4 element pair of said first set of network element pairs for said each
5 network element pair of said first set of network element pairs, and
6 a representation of a delay between network elements of said each network
7 element pair of said first set of network element pairs for said each
8 network element pair of said first set of network element pairs.

1 46. The method of claim 44, further comprising:
2 means for forming a second matrix, wherein
3 said second matrix describes a relationship between a plurality of
4 independent delays and a non-independent delay,
5 said plurality of independent delays comprise a delay between network
6 elements in each network element pair of said second set of
7 network element pairs, and
8 said non-independent delay comprises a delay between network
9 elements in a network element pair of said first set of network
10 element pairs that is not in said second set of network element
11 pairs.

1 47. The computer system of claim 46, wherein said means for forming said
2 second matrix comprises means for performing a Gaussian elimination using said first
3 and said second matrices.

1 48. The computer system of claim 46, wherein said means for computing
2 said computed network performance metric comprises:
3 means for multiplying said measured performance metric by an element of
4 said second matrix.

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